

WHAT IS CLAIMED IS:

1. A communications device comprising:

a general purpose computer including at least one central processor, a memory storing program instructions to be executed by the processor, a user input/output mechanism coupled to the central processor, and a plurality of expansion slots coupled to the central processor through a bridge circuit; and

at least one network interface card plugged into one of the expansion slots and being controlled, at least in part, by the processor, wherein the at least one network interface card comprises an ATM (Asynchronous Transfer Mode) card;

wherein the program instructions executed by the processor enable the communications device to implement multiprotocol label switching (MPLS) using label distribution protocol to communicate with other communications devices, the program instructions including:

a set of computer instructions for determining that the memory stores an outgoing packet;

a set of computer instructions for assigning a VPI.VCI (virtual path identifier, virtual circuit identifier) label to the outgoing packet, the VPI.VCI label assigned using label distribution protocol;

a set of computer instructions for forwarding the packet to the ATM network interface card to be output with the VPI.VCI label;

a set of computer instructions for receiving an incoming packet on an incoming channel, the incoming packet being an IP (Internet Protocol) packet labeled with a VPI.VCI label; and

a set of computer instructions for forwarding the incoming packet to an IP handler, the IP handler comprising software instructions operating on the general purpose computer.

2. The device of claim 1 wherein the memory further stores an operating system with computer instructions to be executed by the processor, the operating system comprising a Linux operating system.

3. The device of claim 1 wherein communications device comprises a core label switched router, the communications device receiving an IP packet labeled with a VPI.VCI label and forwarding the IP packet using a second VPI.VCI label.

4. The device of claim 1 wherein the program instructions further comprise a set of computer instructions for opening the endpoint of an ATM permanent virtual circuit (PVC) on the ATM

network interface card coupled to a downstream label switch router, characteristics of endpoint being specified by label distribution protocol.

5. The device of claim 4 wherein the program instructions further comprise a set of computer instructions for closing the PVC connection when the connection is no longer needed.

6. The device of claim 1 wherein the program instructions further comprise a set of computer instructions for instructing an operating system kernel executing on the central processor to send IP packets on the destination virtual circuit that corresponds to an MPLS label that is associated with a class of IP packets.

7. The device of claim 1 wherein the program instructions further comprise a set of computer instructions for translating the VPI.VCI label to an IP address and forwarding the packet to a non-MPLS downstream router.

8. The device of claim 1 and further comprising an Ethernet card plugged into one of the expansion slots.

9. A computer readable storage medium for storing a computer program, the computer program comprising computer instructions for:

determining that an Internet Protocol (IP) stream can be utilize multiprotocol label switching (MPLS);

requesting a VPI.VCI label from a downstream label switching router (LSR), the requesting being made using label distribution protocol;

associating the IP stream with a VPI.VCI label received from the downstream LSR;

opening an ATM PVC (asynchronous transfer mode permanent virtual connection) connection on an ATM NIC (network interface card) connected to the downstream LSR, the PVC connection associated with the VPI.VCI label received from the downstream LSR; and

instructing an operating system kernel to send IP packets with a destination that matches the IP prefix of the received IP stream to the PVC connection.

10. The storage medium of claim 9 and further comprising computer instructions for: receiving an IP packet from a upstream LSR; and

forwarding the received IP packet to the downstream LSR via the ATM NIC, the forwarding being based upon the VPI.VCI label.

11. The storage medium of claim 9 wherein the computer program further comprises computer instructions for closing the PVC connection when the connection is no longer needed.

12. The storage medium of claim 9 wherein the storage medium is fixedly attached within the housing of a general purpose computer.

13. The storage medium of claim 9 wherein the computer readable memory comprises a RAM.

14. The storage medium of claim 13 wherein the storage medium comprises a DRAM.

15. The storage medium of claim 13 wherein the storage medium comprises a non-volatile memory.

16. The storage medium of claim 15 wherein the storage medium comprises a hard drive.

17. The storage medium of claim 15 wherein the storage medium comprises a CD-ROM.

18. The storage medium of claim 9 wherein the storage medium comprises more than one physical memory device.

19. A computer readable storage medium for storing a computer program, the computer program comprising computer instructions for:

receiving a request for a VPI.VCI (virtual path identifier.virtual circuit identifier) label from a upstream label switched router (LSR), the request using label distribution protocol;

determining a VPI.VCI label for the given Internet Protocol (IP) stream;

communicating the VPI.VCI label for the given IP stream to the upstream LSR, the

communicating using label distribution protocol;

opening an endpoint of an ATM PVC (asynchronous transfer mode permanent virtual connection) on an ATM NIC (network interface card) connected from the upstream LSR, the ATM PVC connection utilizing the VPI.VCI label;

instructing an operating system kernel to send packets received at the PVC connection at the ATM NIC to an IP input handler; and

forwarding the packet of information to a downstream router, the forwarding being based upon the IP address.

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20. The storage medium of claim 19 wherein the storage medium is fixedly attached within the housing of a general purpose computer.

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21. The storage medium of claim 19 wherein the storage medium comprises a dynamic random access memory.

22. The storage medium of claim 19 wherein the storage medium comprises a non-volatile memory.

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23. The storage medium of claim 22 wherein the storage medium comprises a hard drive.

24. The storage medium of claim 22 wherein the storage medium comprises a CD-ROM.

25. A computer readable storage medium for storing a computer program, the computer program comprising computer instructions for:

receiving a request from an upstream LSR that the upstream LSR wants to send a given IP stream, the request using label distribution protocol;

requesting that a downstream LSR provide a label for the given IP stream, the request using label distribution protocol;

25 receiving an outgoing VPI.VCI label from the downstream LSR, the receiving using label distribution protocol;

sending an incoming VPI.VCI label to the upstream LSR, the receiving using label distribution protocol;

30 opening a first ATM PVC connection on an incoming ATM NIC connected to the upstream LSR, the ATM PVC connection utilizing the incoming VPI.VCI label;

opening a second ATM PVC connection on an outgoing ATM NIC connected to a downstream LSR, the ATM PVC connection utilizing the outgoing VPI.VCI label; and

instructing an operating system kernel to send packets received at the first PVC connection to the second PVC connection.

26. The storage medium of claim 25 wherein the storage medium is fixedly attached within the housing of a general purpose computer.

27. The storage medium of claims 25 wherein the computer readable memory comprises a DRAM.

28. The storage medium of claim 25 wherein the storage medium comprises a non-volatile memory.

29. The storage medium of claim 28 wherein the storage medium comprises a hard drive.

30. The storage medium of claim 28 wherein the storage medium comprises a CD-ROM.

31. A method of using a general purpose computer as an MPLS-enabled label switched router, the general purpose computer executing software that allows it to communicate with other label switched routers using label distribution protocol, the general purpose computer including a keyboard, a mouse and a display device for communicating with a local user.

32. A communication device comprising:
a non-MPLS enabled ATM switch including ATM inputs and ATM outputs; and
a general purpose computer coupled to the non-MPLS enabled ATM switch, the general purpose computer executing software to communicate with the non-MPLS enabled ATM switch through third party call control, the general purpose computer executing software that enables the non-MPLS enabled ATM switch to utilize MPLS.

33. A method of implementing label switched router that includes a non-MPLS enabled asynchronous transfer mode (ATM) switch and an attached processor, the method comprising:
determining that an IP (Internet Protocol) stream can be utilize MPLS;
requesting a VPI.VCI label from a downstream label switching router (LSR), the requesting being made using label distribution protocol;

associating the IP stream with a VPI.VCI label received from the downstream LSR;

assigning a local label to be used for a connection between the attached processor and a switch port of the ATM switch, the local label being assigned by the attached processor and the switch port of the ATM switch being connected to the downstream LSR;

5 creating a switched virtual circuit connection (SVC) from the attached processor to the switch port of the ATM switch using the local label, the switched virtual circuit connection being signaled using TPCC;

instructing an operating system kernel to send IP packets with a destination that matches the IP prefix of the received IP stream to the SVC; and

10 sending IP packets from a memory within the attached processor to a NIC card in the attached processor with the local label; and

 sending IP packets from the NIC card in the attached processor to the ATM switch.

34. The method of claim 33 and wherein sending a setup message comprises sending a Q.2931 setup message from the attached processor to the ATM switch.

35. A method of using label switched router that includes a non-MPLS enabled asynchronous transfer mode (ATM) switch and an attached processor, the method comprising:

receiving a request for a VPI.VCI (virtual path identifier.virtual circuit identifier) label from a upstream LSR, the request using label distribution protocol;

determining a VPI.VCI label for the given IP stream;

communicating the VPI.VCI label for the given IP stream to the upstream LSR, the communicating using label distribution protocol;

25 assigning a local label to be used for a connection between the attached processor and the ATM switch, the local label being assigned by the attached processor;

 creating a switched virtual circuit connection from the attached processor using the local label to the external interface using the external label, the switched virtual circuit connection being signaled using TPCC;

30 instructing the operating system kernel of the attached processor to send packets received at the switched virtual circuit connection at an ATM NIC of the attached processor to an IP input handler; and

 forwarding the packet of information to a downstream router, the forwarding being based upon the IP address.

36. The method of claim 35 and further comprising sending the incoming IP stream from the attached processor to a destination router.

37. The method of claim 36 wherein the incoming IP stream is sent from the attached processor to a non-MPLS link.

38. The method of claim 37 wherein the non-MPLS link comprises an Ethernet link.

39. The method of claim 37 wherein the non-MPLS link comprises a link selected from the group consisting of a PPP dial modem connection, a token ring link, DEC net link, an apple talk link, and an ATM link.

40. The method of claim 35 and wherein the attached processor listens for incoming packets on the on the local virtual connection and sends all of the incoming packets to an IP layer of a protocol stack.

41. The method of claim 35 and wherein sending a setup message comprises sending a Q.2931 setup message from the attached processor to the ATM switch.

42. The method of claim 35 and further comprising closing the external virtual connection when the external virtual connection is no longer needed, wherein the external virtual connection is caused to be closed by sending a Q.2931 release message from the attached processor to the ATM switch.

43. A method of using label switched router that includes a non-MPLS enabled asynchronous transfer mode (ATM) switch and an attached processor, the method comprising:

receiving a request from a upstream LSR that the upstream LSR wants to send a given IP stream, the request using label distribution protocol;

requesting that a downstream LSR provide a label for the given IP stream, the request using label distribution protocol;

receiving an outgoing VPI.VCI label from the downstream LSR, the receiving using label distribution protocol;

sending an incoming VPI.VCI label to the upstream LSR, the receiving using label distribution protocol; and

creating a switched virtual circuit connection from an ATM switch interface connected to the upstream using the incoming label to an ATM switch interface connected to the downstream using the outgoing label, the switched virtual circuit connection being signaled using TPCC.

44 43. The method of claim 42 wherein the label switched router determines that is a core router for the incoming IP stream by using label distribution protocol with both the upstream and the downstream.

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45 44. A computer-implemented method of graphically displaying the labels for a virtual connection that is used to transmit an Internet Protocol (IP) stream, the method comprising:
receiving user information specifying an IP addresses of elements in a network that are to be monitored;
displaying an icon for each element;
in response to a refresh indication, querying each of the elements in the network to determine a status for each element;
providing a visual indication of which elements are operational and which elements are non-operational; and
for each pair of elements having a valid label distribution protocol session, displaying a connection between the icons associated with each element in the pair.

46 45. The method of claim 44 and further comprising saving the IP addresses of elements in a network to a non-volatile storage medium.

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47 46. The method of claim 44 and further comprising changing the position of the icons in response to an indication by the user.

48 47. The method of claim 46 wherein the indication by the user comprises clicking on an icon and dragging the icon to a new position.

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49 48. The method of claim 44 wherein the refresh indication is in response to a refresh command from the user.

50 49. The method of claim 44 wherein querying each of the elements to determine a status comprises connecting to a diagnostic port of each element.

51 50. The method of claim 44 wherein providing a visual indication of which elements are operational and which elements are non-operational comprises displaying an icon of a first color for operational elements and an icon of a second color for non-operational elements.

52 51. The method of claim 44 and further comprising:

10 receiving an indication from the user to display a sequence of labels for a selected IP stream;

determining an ingress element for the selected IP stream, the ingress element handling a plurality of IP streams beside the selected IP stream; and

determining which of the plurality of IP streams is the selected IP stream;

displaying a label for the connection between the ingress element and a downstream element; and

displaying a label for the each other hop between elements in the IP stream an egress point is reached.

53 52. The method of claim 51 wherein determining the ingress element comprises receiving an indication from the user as to which element is the ingress element.

54 53. The method of claim 52 wherein the user indicates which element is the ingress element by clicking on the icon of the ingress element.

55 54. The method of claim 51 wherein determining which of the plurality of IP streams is the selected IP stream comprises:

providing a list of the plurality of IP streams to the user; and

receiving an indication from the user as to which IP stream is the selected IP stream.

56 55. The method of claim 54 wherein providing a list of the plurality of IP streams comprises querying the ingress element via its diagnostic port.

51 56. The method of claim 51 and further comprising querying each of the elements in a label switched path for the IP stream to determine the label associated with a connection to that element.

51 57. The method of claim 51 and further comprising labeling the icon associated with an egress
5 element.

59 58. The method of claim 44 and further comprising displaying an IP address for each element in the network to be monitored.

10 59. A computer readable storage medium for storing a computer program, the computer
6 program comprising computer instructions for graphically displaying the labels for a label switched path that is used to transmit an Internet Protocol (IP) stream, the computer program comprising:

a set of computer instructions for receiving user information specifying an IP addresses of elements in a network that are to be monitored;

a set of computer instructions for causing an icon for each element to be displayed;

a set of computer instructions for querying each of the elements in the network to determine a status for each element;

a set of computer instructions for providing a visual indication of which elements are operational and which elements are non-operational; and

a set of computer instructions for displaying a connection between the icons associated with each element in a pair of elements having a valid label distribution protocol session.

61 60. The storage medium of claim 59 wherein the storage medium is one component in a communication device that further comprises a controller, a volatile memory coupled to the
25 controller and a plurality of communication units coupled to the controller.

62 61. The storage medium of claim 60 in combination with the controller, the volatile memory and the communication units, the storage medium coupled for access by the controller.

30 62. The storage medium of claim 60 wherein the communication device comprises an ATM
63 switch.